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Effects of different rearing systems on growth performance, nutrients digestibility, digestive organ weight, carcass traits, and energy utilization in male broiler chickens

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ABSTRACT

A total of 600 male broiler chickens were randomly allocated to 1 of the following 3 rearing systems, multilayer cage rearing system (CRS), litter rearing system (LRS), and plastic flat net rearing system (NRS), to investigate the effects of different rearing systems on growth performance, nutrients digestibility, digestive organ weight, carcass traits, and energy utilization in male broiler chickens with 10 replicate cages or pens and 20 chickens per cage or pen. Growth performance was determined on d 0, 21, and 42, and all other response criteria were determined on d 21or 42. Weight gain and feed conversion ratios were not affected by 3 different rearing systems. However, feed intake in LRS treatment was lower ($P<0.05$) than the other 2 treatments during d 0 to 21.The apparent ileal digestibility (AID) of dry matter and N were not affected by different rearing systems, while CRS treatment had lower AID for energy than other 2 treatments at d 42 ($P<0.05$). Broiler chickens on LRS treatment had a heavier gizzard than other 2 treatments at both d 21 and 42 ($P<0.05$). Carcass yield, breast meat yield, breast weight, and thigh weight were unaffected by different rearing systems at both d 21 and 42. At d 42, thigh yield in broiler chickens on CRS treatment was greater than those on NRS treatment ($P<0.05$). Broiler chickens on CRS treatment had a lower abdominal fat than those on other 2 treatments at d 21 ($P<0.05$). However, it was found that the lowest and the greatest abdominal fat were observed with CRS and LRS treatments, respectively, at d 42 ($P<0.05$). Broiler chickens reared in LRS had lower apparent ileal digestible energy intake than those in CRS and on NRS during d 0 to 21 ($P<0.05$). Apparent ileal digestible energy (AIDE), net energy for production, energy retained as fat (RE_f) and protein (RE_p), efficiency (k) of AIDE use for total retention (kRE), lipid retention (kRE_f), and protein retention (kRE_p) did not differ among the treatment groups at any point during the experimental period. In conclusion, the results of the current study indicated that growth performance, energy retention (RE_f and RE_p), and efficiencies of energy utilization (kRE, kRE_f, and kRE_p) were >unaffected by different rearing systems. In addition, broiler chickens reared in CRS had lower AIDE than those reared in other 2 rearing systems during the later phase.

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1. Introduction

Broiler chicken rearing systems are crucial to affecting chicks' health, welfare, and production efficiency. In many Asian countries, especially China, there are 3 primary intensive systems for broiler chicken production, multilayer cage-rearing system (CRS), litter rearing system (LRS), and plastic flat net-rearing system (NRS). Generally, LRS requires more floor space, but the feeding device cost is cheap, and broiler chickens raised in LRS had lower incidence of breast blisters and leg abnormalities (Simpson and Nakaue, 1987). Broiler chickens raised in NRS can keep chickens away from excreta and maintain good environmental hygiene, therefore reducing the occurrence of disease (Mariam et al., 2012). Furthermore, litter is not necessary in NRS, and this will reduce the cost and the amount of work. Multilayer cage-rearing system is well known for better space utilization. Because space is very expensive in China, the use of CRS to raise broiler chickens instead of LRS could lead to a reduction in production cost and therefore, price of poultry products. Moreover, broiler chickens raised in CRS could also provide better hygienic conditions than those raised in LRS (Willis et al., 2002).

Several studies have been conducted to evaluate the effects of CRS and LRS on broiler chicken performance; however, results were not always consistent. Fortomaris et al. (2007) and Santos et al. (2012) concluded that male broiler chickens reared in LRS had superior growth performance than those reared in CRS. However, Mariam et al. (2012) favored CRS for better performance and economy. In addition, Ebrahim et al. (2013) found no differences for rearing system (CRS vs. LRS) on daily feed consumption, daily weight gain, or feed conversion ratio (FCR) in male and female broiler chickens. Few studies have been conducted on the effects NRS on broiler chicken performance and other traits. In addition, energy is the main dietary component for all animal species. Most of the research conducted on determining broiler chickens energy utilization has been carried out in cages (Latshaw and Moritz, 2009; Lopez et al., 2007), it is not clear how energy utilization may vary based on LRS and NRS. Therefore, the current experiment was designed to evaluate the effects of 3 different rearing systems on growth performance and energy utilization in male broiler chickens.

2. Materials and methods

2.1. Experimental design and dietary treatments

The experimental protocol of the current study was approved by the Animal Care and Use Committee of Feed Research Institute, Chinese Academy of Agricultural Sciences (Beijing, China). To accentuate any difference that exists between production systems, efforts were made to keep factors such as breed, sex, diet, stocking density, and husbandry and environmental conditions as identical as possible. A total of 600 1-day old healthy commercial male Arbor Acres broiler chickens with the initial body weight 46.89 g, purchased from a local commercial hatchery (Huadu Broiler Corp., Beijing, China), were randomly assigned to 3 treatments with 10 replicate cages or pens and 20 chicks per cage or pen in the same building. Broiler chicks on the CRS treatment were placed in a 2-tier-cage stainless steel barrier with one-side trough feeders. Broiler chicks on the LRS treatment were placed on concrete floor covered in clean rice hulls to a depth of 10 cm (one plastic hanging feeder per pen) with stainless steel barrier. Broiler chicks on the NRS treatment were placed on stainless steel frame covered with a flat plastic net with 0.5 cm diameter mesh holes (one plastic hanging feeder per pen). Each cage or pen in this experiment was 100 × 90 cm with 5 nipple-type automatic waterers in one side of cage or pen. The temperature was maintained at 33 °C in the first week and reduced by 3 °C per week until a temperature of 24 °C was achieved.

Two corn–soybean-based diets were formulated to meet or exceed all the nutrient requirements for the starter (d 0 to 21, crumb pellet form) and grower (d 21 to 42, pellet form) phases (CCFSR, 2004; Table 1). Feed and water were provided ad libitum throughout the experimental period. Chlortetracycline was administered in solution in water from d 0 to 7. Lighting was provided 24 h for the first week after hatching, and, thereafter, a light pattern of 20 h light:4 h dark was adopted for the entire experimental period.

2.2. Growth performance

Body weight and feed consumption were determined at d 21 and 42. Weight gain, feed intake, and FCR were calculated for starter, grower, and overall periods. Broiler

Table 1
Composition of diets (as-fed basis)[a].

Item	0 to 21 d	21 to 42 d
Ingredients (%)		
Corn	52.59	58.19
Soybean meal	36.18	32.41
Corn gluten meal	3.00	–
Soy oil	3.76	5.01
Dicalcium phosphate	1.72	1.85
Limestone	1.17	1.14
Salt	0.35	0.34
L-Lys•HCl	0.15	0.01
DL-Met	0.08	0.05
Vitamin-trace mineral premix[b]	1.00	1.00
Chemical composition		
DM (%)[c]	92.16	92.05
CP (%)[c]	21.39	19.74
Ca (%)[c]	1.11	0.93
Total P (%)[c]	0.73	0.64
Available P (%)[d]	0.45	0.40
AME (MJ/kg)[d]	12.55	12.97
Available Lys (%)[d]	1.15	0.93
Available Met (%)[d]	0.41	0.32
Available Met+Cys (%)[d]	0.74	0.61
Available Thr (%)[d]	0.74	0.63

[a] AME = apparent metabolizable energy; DM = dry matter.
[b] Supplied per kilogram of diet: vitamin A, 8,050 IU; vitamin D_3, 1,800 IU; vitamin E, 20 IU; vitamin K_3, 5.1 mg; vitamin B_1, 2.4 mg; vitamin B_2, 8.2 mg; vitamin B_5, 15.3 mg; vitamin B_6, 3.1 mg; vitamin B_{12}, 0.02 mg; niacin, 32 mg; choline chloride, 1,000 mg; biotin, 0.20 mg; folic acid, 1.20 mg; Mn, 68 mg; Fe, 85 mg; Zn, 58 mg; Cu, 8.60 mg; I, 0.27 mg; and Se, 0.20 mg.
[c] Analyzed values.
[d] Calculated values (Xiong et al., 2012).